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MANAGEMENT OF TREES USED IN *MURSIK* (FERMENTED MILK) PRODUCTION IN TRANS-NZOIA DISTRICT, KENYA

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ABSTRACT.– Milk treatment using trees is an age-old practice of both sedentary and nomadic pastoral communities in Kenya. Due to economic, political and environmental pressures, many pastoralists have become settled farmers and turned to crop cultivation as their main means of survival. However, they have continued to keep some cows and to treat their milk using traditional practices, incorporating the desired tree species into their farming system. This paper presents information as to how species are identified and selected, how the trees are managed, management problems associated with the trees, and how farmers evaluate the results of continuing experimentation with trees used for ***mursik*** production.

Key words: Fermented milk, ***mursik***, pastoralism, farming, Kenya

RESUMEN.–Tratamiento de leche usando arboles es una antigua practica de comunidades pastoriles sedentario y nómadas en Kenya. Por la influencia económico, política y ambiental, muchos ganaderos se hacen agricultores y se mantienen con las cultivación de comida cómo su superviviente. Además, ellos siguen manteniendo vacas y tratando la leche con prácticos tradicionales, incorporando los arboles necesarios en su sistema de agricultura. Este papel va presentar información en cómo los especies se identifican y escojan, cómo los arboles se mantienen, problemas con los arboles, y como los granjeros evalúan los resultas de los experimentos continuos con los arboles en el uso del producción ***mursik***.

RESUME.– Le traitement du lait à partir de certains arbres pour la production de *mursik* est une pratique ancienne des communautés pastorales à la fois sédentaires et nomadiques au Kenya. A cause des pressions économiques, politiques et écologiques au cours des années, beaucoup de pastoralists sont devenus des cultivateurs comme moyen principal de survivre. Néanmoins, ils continuent d'élever des vaches laitières et d'utiliser leurs pratiques traditionnelles de traitement du lait en incorporant des espèces d'arbres utiliser pour ce but dans leurs champs. Cet article présentera des informations sur l'identification et la sélection des espèces, la gestion de ces arbres, les problèmes de gestion rencontrées, et les méthodes employées par les éleveurs pour évaluer les résultats des leurs expérimentations continuelles avec des espèces d'arbres utilisées pour la production de ***mursik***.

INTRODUCTION

Tree diversity is generally low in farming systems compared to natural ecosystems such as forests. Even so, forest and tree resources provide many benefits and form an important part of the rural household economy. Trees are used in various ways for economic, social and cultural purposes. To a large extent, rural people themselves determine the tree species that grow on their farms and influence each other in terms of what agroforestry practices to adopt or to reject. Extensive discussions with farmers in Trans-Nzoia District, Kenya, revealed that every tree growing on farmers' land has a role to play in the household economy. However, as some common and widely used tree species are facing extinction in both their natural and human-modified habitats due to population pressures and increasing demand for cultivation land, efforts should be made to document the uses of tree resources so that good cultivation and conservation practices can be developed.

Such is the case with the tree species[1] used for the preservation of milk for the production of ***mursik***, a traditional technology developed and widely used by various pastoral groups in Kenya. ***Mursik*** is the Kalenjin term for fermented milk, but the term is recognized and used by all ethnic groups in the research area. To date, little has been written about traditional milk preservation practices in Kenya. Articles found in most cases provide only very brief descriptions of the technology. Even the series of district socio-cultural profiles published in the mid-1980s devote only a few paragraphs to describing the technology (e.g., Were and Wanjala 1986; Wanjala and Nyamwaya 1986; and Were and Olenja 1986). Other articles summarize the process of sour or fermented milk production as an introduction to their main topic, the microbiological analysis of fermented milk products (e.g., Miyamoto *et al.* 1985; Ashenafi 1993; Feresu 1992; Isono *et al.* 1994; Kassaye *et al.* 1991; Mutukumira 1995; Mutukumira *et al.* 1995; and Nakamura *et al.* 1999). Shalo (1987) provides a generalized description of the pastoral methods of handling and preserving milk practiced in Kenya, paying particular attention to the initiation and preparation of the milk storage gourds. The technology, however, is not restricted to Kenya, but is widely used in other Africa countries as well, for example the Sudan (Abdelgadir *et al.* 1998), Zimbabwe (Feresu 1992; Mutukumira *et al.* 1995; Mutukumira 1995), Tanzania (Isono *et al.* 1994) and Ethiopia (Ashenafi 1994; Kassaye *et al.* 1991).

More detailed descriptions of the process to produce ***iria ri matii***, a fermented milk produced by the Meru, is provided by Kimonye and Robinson (1991), while the production of ***mursik*** is described by an anonymous author in Food Chain (Anon. 1994). The Meru people use charcoal from *Olea europaea* L. ssp *africana* (Mill.) P.Green to coat the inside of storage gourds; the attractive flavour/aroma of wood smoke is an essential characteristic of the product. The authors also describe the microbiology of the process involved. Wanjala and Nyamwaya (1986) reported about the production of ***murskik*** (sour milk) among the Tugen in Baringo District using charcoal obtained from *Euclea divinorum* Hiern. The purpose of doing so, according to these authors, is threefold: (1) it preserves the milk for a longer period; (2) sour milk is a strong and healthy meal in itself; and (3) it gives the milk colour and scent. The charcoal crushed into the gourd keeps it from wearing out fast, and it also erases the natural smell of a gourd when milk is drunk from it. Similar procedures are used by the Pokot and the Ilchamas (Wanjala and Nyamwaya 1986), but no mention is made of the species used for the charcoal to coat the milk storage gourds.

The Maasai in Kajiado District use *Olea europaea* L. for the treatment of their gourds for the preparation of ***osaroi*** (sour milk), which is believed to assist milk in fermentation and "gives it a pleasant flavour enjoyed by the Maasai people" (Were and Wanjala 1986). From the description given by Were and Wanjala (1986), it is unclear whether the Maasai coat the gourds with charcoal as is done by the Tugen, Pokot and Ilchamas, or whether the gourds are only smoked with a burning piece of wood. Miyamoto *et al.* 1985 reported on the production of ***maziwa lala*** (Kiswahili for sour milk) by the Maasai in Nakuru, Narok and Kajiado Districts of the Rift Valley Province in Kenya. In a brief description on the preparation methods of ***maziwa lala***, Miyamoto *et al.* state that a gourd is washed with hot water and rubbed with the burnt end of some chopped sticks from a tree known as ***mutamayio*** (this tree could not be identified in Beentje (1994) or in other sources). This is done for both flavouring and pasteurizing. An anonymous author writing in the journal Food Chain (1994) about milk preservation by the Kalenjin in Baringo District provided a good description of the process of milk preservation using charcoal, as well as an explanation of how the technique works to preserve the milk. Like the other studies, the author identified only one tree used for this purpose (***ite***), but did not provide a scientific name of this species. ***Ite*** could refer to *Acacia mellifera* which is spelled as ***Iti*** in Samburu and ***Oete*** or ***Eite*** in Maa according to International Centre for Research in Agroforestry (ICRAF)(1992), or ***Oiti*** according to Beentje (1994). According to Ronoh (1987), the methods used to preserve milk by the Maasai, Kalenjins, Boranas, Turkanas, Pokot and Somalis are such that milk can be kept as long as three months.

Riley and Brokensha (1988) briefly described milk preservation practices among the Mbeere, who live on the semi-arid plains south of Mt. Kenya. The Mbeere use smoke to sterilize the gourds used for milk storage, contrary to farmers in the above mentioned studies who use charcoal. Nevertheless, the charcoal may still smoke when crushed in the gourds, thus indirectly providing this sterilizing service as reported in the article "***Mursik*** - Fermented milk in Kenya" (Anon.,1994). Several tree species are used by the Mbeere to smoke their gourds, but they are different from those used by farmers in the other studies cited above, reflecting the different ecological and biogeographic conditions in each area. Kassaye *et al.* (1991) also reported on the use of smoke to prepare the storage gourds for the preparation of ***ititu*** (or concentrated, fermented milk) by pastoralists in Southern Ethiopia. Pastoralists there use wood from *Acacia nilotica* (L.) Willd. ex Delile to smoke the gourds. Another study from Ethiopia (Ashenafi 1994) also mentioned the smoking of fermenting vessels with *Acacia nilotica* wood by pastoralists in rural areas. In the highlands, however, smoking of containers with olive wood is more common according to Ashenafi (1994). Smoking of milk gourds is also used by the Turkana as reported by Galvin (1985).

The above studies indicate that the use of charcoal and smoke from selected tree species is widespread among pastoral people in East Africa. However, the authors (with the exception of Riley and Brokensha 1988) make it appear is if each ethnic group only uses one specific species for the treatment of their milk, which may or may not be the case. In addition, none of these studies report on the tree species themselves, such as where pastoralists obtain the wood, whether the trees used in the process are actively planted and managed, or the specific problems farmers encounter using the technology (in particular related to the trees employed for the process) and ways they have tried to solve them. This article will address some of these gaps. It is based on a study of milk treatment by farmers in Trans Nzoia District, Kenya. Our intention is not to provide a detailed description of the milk preservation process as such, but to provide more information about the trees associated with the technology and their management.

OBJECTIVES

The integration of woody species with crops and animals is an age-old practice of people throughout the world. The formal study of what is now termed agroforestry, however, started only about 20 years ago. Despite heavy investment in research and extension in these two decades, agroforestry efforts have met mixed success, largely because researchers and extensionists have not paid sufficient attention (if any at all) to farmers' experiences with systems designed and developed through their own efforts (den Biggelaar 1996a). The realization that, independently of formal research and extension, farmers and communities in every country carry out spontaneous experimentation on tree cultivation and management, and share findings with others, led to a major initiative by the Forest, Tree and People Programme (FTPP) to document these informal research and extension practices. A case study format was chosen by FTPP as the best way to study farmers' experimental and information sharing practices and processes, enabling outsiders to understand their underlying rules and logic in different regions around the world.

The objectives of the case studies were two-fold:

1. To document how selected farmers organize experiments and disseminate improved forest and tree management practices. The case studies were geared less at describing specific improved practices, but more at developing an understanding of the "why" and "how" aspects behind the practices.
2. To define the current and potential role (if any) for outside institutions (e.g., NGOs, research, extension, donor-funded projects, universities) to support farmers in the above endeavors.

The study presented in this paper was one of four case studies undertaken in East Africa as part of the global FTPP initiative, and was guided by the above objectives. The specific topic was chosen after preliminary discussions with key informants in Trans-Nzoia District. The informants suggested milk treatment for this study, as it was an innovation developed by pastoral people themselves that is culturally important, widely spread across different ethnic communities in the research area, and still much in use to this day. For example, Kalenjin-speaking people (Kipsigis, Nandi and Tugen among others) believe that milk cannot be consumed fresh, but must undergo treatment before consumption. During the initial visit to the area, farmers mentioned several problems that could impede the future use and further development of the technology. Chief among these problems are the dwindling supplies of certain favoured tree species used for milk treatment in spite of having incorporated some of these species into the farming systems. However, a more thorough understanding of the technology and the exact nature of the problems would be necessary to determine how outside institutions could help farmers maintain and develop the technology further.

This study investigated the nature of the milk treatment procedures used by farmers in Trans Nzoia District, origins of the technology, and the selection, management, and incorporation of trees used for this purpose within the farming system. We conclude the paper by identifying a number of areas in which research and development could be of assistance to improve and extend the use of this technology as a viable alternative to modern, expansive, capital-intensive milk processing plants.

METHODOLOGY

Data collection and analysis.– The study was carried out in a three months period between August and October 1996, and consisted of three stages. Stage one involved a reconnaissance tour of the District by the researchers from Moi University together with the area agricultural extension officer and representatives of the Kaisagat Environmental Conservation Youth Group to identify the topic of the case study. During the tour, interviews were conducted with key informants (individual farmers and farmer groups). The majority of participating farmers were traditional pastoralists who had settled in the District and turned to farming as a survival strategy. They had a highly developed traditional knowledge on the use of tree resources for fodder, medicine (for livestock and human beings), food and milk preservation. Traditionally, these communities did not plant trees since natural regeneration ensured a sufficient supply of trees for various uses. The demand for land for settlement and crop production, however, reduced forest cover and tree species diversity. Nowadays, farmers are actively planting and conserving tree species, especially those which address their cultural and economic needs such as species suitable for milk treatment.

Stage two involved collection of data from individual households. This stage involved direct observation of the milk preservation procedures used by farmers, and the use of structured interview schedules and informal interviews about the process, tree species used and their management, and problems and constraints encountered. A multistage sampling method from division to location was adopted to ensure that all ethnic groups in the two locations were included in the sample. Within the district, two divisions (Cherangani and Kwanza) were chosen randomly; in turn, one location was chosen at random in each of the two divisions. In each location, households of different ethnic groups were chosen based on their perceived knowledge and expertise of milk treatment based on information from key informants. Since women are the custodians of indigenous knowledge in the area of food preservation, the sampling procedure was directed towards them. However, both the head of the household and his spouse (if applicable) were interviewed. A total of 60 farmers (36 from Cherangani and 24 from Kwanza) were interviewed. Semi-structured interview schedules were used to guide the interviews to assure that similar information was collected from each household. Nevertheless, based on the answers of respondents, additional questions were posed to seek clarifications and additional information. Questions in these interviews included descriptions of the technology (often including a showing of milk gourds, utensils, prepared branches) to learn how it is milk treatment is done; perceptions of how and why the treatment is effective in preserving milk; choice of species used and their advantages and disadvantages; changes in species used from the past and/or from respondents' area of origin, and the reasons for these changes; location(s) where farmers collect species used in milk treatment; and problems and constraints encountered with the technology in general and the desired species (esp. regarding their multiplication nd management) in particular. A standard form designed by the researchers was used to collect information on each species used and cultivated for the purpose of milk preservation.

Stage three consisted of two community workshops in which the results of the surveys, observations and informal interviews were presented to the community for verification, discussion and further explanation where necessary. Small group discussions using a list of questions were used to further explore key issues related to milk treatment (past, present and future).

Species identification.-In general, species were identified through their vernacular names used by the different ethnic groups in the area. The fact that two of the authors (Mr. Wesakania and Mr. Kamau) are also farmers in the study area, manage a small tree nursery for the youth group they lead, and are knowledgeable of the local vegetation greatly facilitated species identification. All but one of the species used for milk preservation are trees common throughout Kenya with which the Kenyan authors were familiar, and for which they knew both the local and scientific names. The exception was *Lippia kituiensis* (vernacular name is ***Mwokiot*** or ***Mwokyot*** in

Kipsigis), which was identified through Beentje (1994: 668). The identification of all species, however, was verified through consultations of Beentje (1994), ICRAF (1992), Gachathi (1989) and Teel (1984). Additional botanical information on the species was obtained from the Missouri Botanical Garden's W^3 Tropicos VAST nomenclatural database and authority files on the Internet (MOBOT, n.d.).

RESULTS AND DISCUSSION

Study area.–The study was conducted in Kwanza and Cherangani Divisions of Trans-Nzoia District in Western Kenya. The district covers 2,468 km^2 and has an elevation averaging 1800 m asl. Most of the rivers in the district are tributaries of the Nzoia River and flow throughout the year. The district has a highland equatorial type of climate with a fairly well distributed average annual precipitation of 1120 mm, and an average mean temperature of 18.6° C.

The District Development Plan (DDP) of 1994 estimated the district's population at 462,748. Although no concrete data exist as to the exact numbers, there has been a steady in-flow of migrants from different parts of Kenya in the last 30 years (DDP 1994). This was confirmed by the fact that 98% of the farmers interviewed migrated to the district in the last 32 years. The main attraction for migrants into the area was the availability of land for settlement and a favorable climate for both cultivation and livestock.

The tenure system in the area has changed over the years. Initially, much of the land belonged to large individual farmers, mostly British settlers. After Kenya's Independence in 1963, these settler farms were sold as group farms to individual small holders, or were expropriated by the government for settlement schemes and co-operative and corporate farms owned by the Agricultural Development Corporation and the Kenya Seed Company, among others. These large farms have in the recent past been subdivided and given out to individual (mainly smallholder) farmers, although a large number of these are not registered and farmers do not have title deeds to their land.

The total area under forest in the district is 50,292 hectares, but immigration and settlement have led to serious deforestation in many parts of the district. The incorporation of trees and shrubs in the farming systems has partly mitigated the loss of natural forests. Agroforestry has become one of the primary production activities in the district, supplying the bulk of the about 500,000 m^3 of fuel wood consumed annually (DDP 1994). Demand for fuel wood is bound to increase due to an increasing population. Through the combined efforts of the Forest Department and NGOs, over four million seedlings are produced and supplied to farmers annually to meet the growing demand for fuel wood and other tree products. The survival rate has, however, been very low, not exceeding 30% each year according to Forest Department and extension personnel. One of the reasons for the low survival rate is that seedlings provided are mostly exotics with no cultural importance, leading to a lack of proper care to ensure survival.

Dairy farming is a major economic activity and constitutes a large proportion of income for both the small and large-scale farmers. Farmers experience problems in the marketing of their milk due to lack of storage facilities and a poor transportation system. The dairy market is poorly developed in the district, with Kenya Cooperative Creameries (KCC) being the only commercial buyer of milk produced in the area; delayed payments for milk delivered to KCC exacerbated the problems experienced by farmers during much of 1995 and 1996. The need to treat and preserve milk at the farm level has, therefore, increased in importance despite the availability of modern milk processing facilities in Kenya.

Problems that led to uses of trees in milk treatment.–The use of trees in milk treatment is a common practice among farmers in Trans-Nzoia District. The technology has been practised for a long time by pastoral communities, and non-pastoralists (e.g., the Kikuyu) have adopted this practice from them. The farmers identified the following problems and conditions leading to their experimentation with milk treatment:

- Milk is a major source of food for pastoral people, but many Africans are lactose intolerant. Fermentation is, therefore, necessary to improve the digestibility of milk.
- The odour, taste, and flavour of fresh milk are not pleasing (farmers are of the opinion that fresh milk smells and tastes like cow urine) and need to be improved before it can be consumed. The charcoal helps to neutralize the undesirable odour and taste of the milk. Shalo (1987) reported that the finely divided charcoal inside the gourds has a wide surface area, and hence is very active absorbent of flavours in milk. The charcoal itself also imparts flavour to the milk (Shalo, 1987)
- The white colour of milk is not acceptable to farmers, who accord a high aesthetic value to the bluish-grey colour imparted to the milk by the charcoal. Similar findings were reported by Anon. (1994) and Shalo (1987).
- Lack of markets and refrigeration, and the need to store milk for the dry season (when milk production decreases due to a lack of pasture) required that excess milk be stored for longer time. There was, therefore, a need to preserve the milk and improve its shelf-life. For example, the Pokot developed ***chekha mwaka***, a specially treated milk that could be stored for over one year without spoiling (findings from interviews for this study). This is much longer than the up to 3 month shelf-life reported by Ronoh (1987) earlier.
- Gourds were and still are the best storage facilities to the farmers; they are cheap and easily available. However, gourds give milk stored in them a bitter taste. Moreover, gourds are hard to clean and produce a bad smell that affects the milk stored in them. Thus, treatment of milk was also necessary to neutralize the bad smell and bitter taste of the gourds.

Table 1 summarizes the reasons cited by respondents of why they treat their milk. Enhancement of taste and flavour was cited by 86% of the respondents as a reason for treating milk, although it was more important to farmers in Cherangani (92%) than to farmers in Kwanza (79%). The second reason cited was palatability (in the sense of being merely agreeable (WWWebster Dictionary, 2000) (75%), followed closely by the necessity of preserving the milk (cited by 73%). Again, there are differences between the two Divisions, with preservation being more important to Cherangani farmers (83%) and palatability being more important to Kwanza farmers (79%). The differences between the two Divisions are largely due to the ethnic affiliations of the respondents. The medicinal value of treated milk was cited by 18% of respondents, but was more important in Kwanza (25%) than in Cherangani (14%).

The medicinal properties attributed to treated milk are imparted to it through the use of tree species that are known to cure diseases in animals or people. Medicinal tree species are the most frequently used species for milk treatment, as will be shown later. New species are often identified through already known medicinal use. We also surmise that fermented milk may be beneficial to establishing a healthy intestinal flora, which is similar to the use of yoghurt for this purpose in Western cultures. Shalo (1987) mentioned that charcoal, being a material intermediate between wood and ash, contains minerals that will benefit the nutritional value of milk which may, unintentionally, contribute to the overall health of its consumers.

Milk treatment procedure.– The first step in the treatment process involves the preparation of the milk storage gourds. Women use the stalk (central nerve) of palm leaves to scrape the inside of the gourds to remove old fat and milk solids that cannot be removed by washing only. A few days before milk is to be treated, a small branch of a selected tree species, about the thickness of a thumb, is debarked and left to dry. One end of the dried piece of wood is then put in the fire to burn. When the end is completely burnt, it is gently crushed on the side and bottom of a cleaned milk storage gourd to crush it into charcoal dust. This procedure is repeated several times until the gourd is completely coated on the inside. The excess dust is removed, and the gourd is then ready for milk storage. The quality of ***mursik*** (treated milk) obtained through this process is evaluated using the criteria of colour, smell and taste of the final product. Farmers claimed that their traditionally treated milk was superior to untreated milk or factory-processed milk from KCC.

A question in the community workshops about when the process was first used led to much lively discussion. Tracing oral histories and using age groups, participants agreed that the earliest reference would place its development about 300 years in the past. As there are no written documents to verify this, we ac-

TABLE 1.– Problems and conditions underlying the need for milk treatment.

Condition/problem	**% of respondents**		
	Total (n=60)	**Cherangani** (n=36)	**Kwanza** (n=24)
Taste/flavor	86	92	79
Palatability	75	83	58
Preservation	73	72	79
Smell	65	67	63
Color	55	14	25
Medicinal	11	50	63

NB: Multiple responses were allowed.

cepted this as a reasonable date although the technology could in fact be much older. According to the farmers present at the discussion, little has changed in the treatment procedures over time, although the species used have changed especially after people migrated to new areas where old, favoured trees could not be found.

Tree identification and selection procedure.– According to oral histories collected during the exercise, the identification, selection and recommendation of the tree species and their parts to be used in milk treatment was a systematic exercise. It involved the participation of both men and women, but the role of men varied between communities. For example, among the Kikuyus (a traditional farming community), the men are involved in both identification of suitable species and the treatment of the milk. In traditional pastoral communities (for example, Kalenjin and Pokot), both men and women are involved in identification of suitable tree species, but only women would do the actual milk treatment. It should be noted, though, that over time the role of men in the exercise has gradually declined in these communities; women are now solely responsible for the development, implementation and maintenance of the technology.

Not all tree species are suitable for milk treatment. The choice of species and the tree parts to be used are based on: (1) the availability of the species from natural forests or tree patches, and (2) prior knowledge about the species, particularly their use for medicinal purposes for both livestock and human beings, or fodder for livestock. The selection process of potential milk treatment tree species involves smelling the leaves of the tree and / or the smoke produced when burning a branch of candidate species. It can also involve the chewing of specific tree parts such as leaves, stem, and bark. Species that produce a pleasant smell and have a good taste, are easy to burn and produce a porous charcoal to facilitate its crushing inside the gourds will be tried on milk on an experimental basis. Whether the tree would be adopted for the purpose of treating milk depended on the quality of the initial treatment trial; evaluation criteria to judge the results of the trial emphasized the quality of the treated milk in terms of taste, colour, smell and shelf-life.

Presently, farmers use the following tree species for milk treatment (in order of preference obtained through a ranking procedure): *Senna didymobotrya* (Fresen.) Irwin&Barneby (syn. *Cassia didymobotrya* Fres.), *Lippia kituiensis* Vatke, *Prunus africana* (Hook.f.) Kalkm., *Olea europaea* L. ssp *africana* (Mill.) P.Green, *Croton macrostachyus* Del., *Olea capensis* L., and *Rhus natalensis* Krauss. Several other species are used as well, but by few farmers (Table 2); they include *Euclea divinorum* Hiern., *Dombeya torrida* (J.F. Gmel.) P.Bamps ssp *torrida* (syn. *D. goetzenii* K. Schum.), *Bridelia micrantha* (Hochst.) Baill., and *Acacia gerrardi* Benth. A few exotic species have been experimented on by women in the recent past (e.g. *Acacia mearnsii* DeWild. and *Eucalyptus* spp). *A. mearnsii* (black wattle) was found to have side effects on men, namely the blockage of the urinary tract, while *Eucalyptus* spp were found to be ineffective for the purpose and giving the milk a bad taste (which some farmers described to be similar to cold medicine). These species have therefore been abandoned for use in milk treatment by the communities who tried them (e.g., the Kalenjin). Most of the above species are grown on the farm, but some can be found only in the dwindling natural forests of the district.

Domestication and management of tree species used in milk treatment. – Generally, where farmers have chosen to voluntarily grow trees on their farms, the species planted are carefully selected. In the study area, farmers' choice of species varied according to gender, with men favouring species that provide income (from the sale of charcoal, poles, posts and timber) and women favouring species used in milk treatment or meeting fuelwood needs. It was found that among women, trees which could be used for milk treatment (e.g., *Senna didymobotya*) were preferred over species with a narrow fuelwood focus. However, women considered fuelwood of such species as a valuable secondary product. Because ***mursik*** has a special cultural meaning for women and is important to the welfare of the family, trees that were used to provide milk treatment ingredients were better taken care of by the women than trees providing other products. Species used for milk treatment are nowadays managed primarily by women, but all the members of the household will respect and take care of the trees. Men appreciate the important role of these species in the household economy and will (and can) not cut them for other purposes.

Among communities where milk is a traditional and main source of food (such as the sedentary pastoralists) and where immediate storage and marketing facilities are lacking, trees used for milk treatment are not used for fuelwood or any other purpose. They are planted and managed solely for the purpose of milk treat-

TABLE 2.– Domestication of trees used for milk treatment.

Species	**Households using** (n)	**Households cultivating** (n)	**Off-farm source** (n)	**Other uses**
Senna didymobotrya (Fresen.) Irwin & Barneby (syn. *Cassia didymobotrya* Fres.)	36	39		Fw, M
Lippia kituiensis Vatke	34	34	Neighbor 1	Fw, M
Olea europaea L. ssp *africana* (Mill.) P. Green	27	3	Forest 6	Fw
Olea capensis L.	22	6	Forest -	Fw
Prunus africana (Hook.f.) Kalkm.	18	13		Fw, M, O, P
Rhus natalensis Krauss	7	10	Forest 4	Fw, P
Euclea divinorum Hiern.	3	11	Forest 4	Fw, P
Dombeya torrida (J.F. Gmel.) P. Bamps ssp. *torrida* (syn. *D. goetzenii* K. Schum.)	9	15	Neighbor 1	Fw, O, P, R
Acacia gerrardi Benth.	1	-		Fw, P
Acacia mearnsii DeWild.	5	6	2	Fw, P
Eucalyptus spp	5	27		Fw, P, T
Bridelia micrantha (Hochst.) Baill.	3	13		Fw, P
Croton macrostachyus Del.	5	28		Fw, O, P

Abbreviations: Uses: Fw = Fuel wood; M = Medicinal; O = Ornamentals; P = Poles, posts; R = Ropes; T = Timber ment. In some communities, it is also taboo to cross-over or step on pieces of wood cut for the purpose of milk treatment.

The trees commonly used in milk treatment were found either scattered in the fields or growing around the homestead. There was a good relationship between the three most preferred species as identified in the preference ranking exercise and the presence of these species on the farm (Table 2). *Olea* spp. were widely used for milk treatment and demand for the species was high, but few households cultivated them because of their difficult propagation and management. On the other hand, species like *Eucalyptus* spp and *Acacia mearnsii* ranked very low for milk treatment, but were very common on the farm as they are easy to propagate and manage. The latter species were managed by men, who planted these fast-growing species for income generation through the sale of fencing posts, small timber and charcoal.

In the two divisions, 44 percent of the farmers cultivated all the species they use for milk treatment within their farms; 39 percent cultivated some but not all the species used. The remainder of the farmers (17%) did not grow any milk treatment species on their farms, but instead collected them from common property resources. *Senna didymobotrya* and *Lippia kituiensis* were the most popular species used for milk treatment. Sixty percent of the farmers had planted *Senna didymobotrya* in their homesteads, while fifty-seven percent maintained *Lippia kituiensis* in their fields. *Prunus africana* is another important species used for milk treatment across communities; over 20 percent of the farmers interviewed are cultivating it on their farms.

Senna didymobotrya was planted primarily around the homesteads to enable women to: (1) protect it from browsing livestock; (2) lop some branches whenever they prepared ***mursik*** without having to walk long distances; and (3) minimize interference of the trees with other crops and farming activities including mechanization. The management techniques to maintain the species included protection against livestock, planting using seeds (for all species except *Lippia kituiensis*), and pollarding and thinning to control overcrowding and to stimulate the trees to grow many small branches for use in milk treatment.

Constraints.– Several constraints were identified regarding seed collection and storage, breakage of seed dormancy, and the management of trees. According to the farmers, many indigenous species do not produce seeds, making their propagation difficult. Those that do produce seed may take a long time to reach maturity, as is the case with *Olea capensis* and *O. europaea* ssp. *africana*. Most farmers stated that milk treated with *Olea* species tasted the best but they had to look for alternative species because few trees of these species were remaining in the area. A Gikuyu farmer explained how her husband had brought a piece of olive wood from Kiambu District (over 600 km from Cherangani Division) and how she wisely used that piece for nearly one year in treating her milk. Farmers who do have a few olive trees left on their land carefully guard them and do not allow further cutting. The remaining specimens, often located on grazing fields or near river banks, are carefully protected by the population.

A second problem is access to, and availability of, seedlings of useful and preferred species as they are rarely found in village tree nurseries or the nurseries of the Forest Department and NGOs. The farmers felt that many times their species of priority were not available in the local nurseries, leading them to plant trees about which they had very little local knowledge. This may be one of the reasons why the survival rate of seedlings was very low.

Farmers' research activities on milk treatment.– At the time of the study, farmers stated that they were experimenting with various technologies to solve problems and constraints encountered with the cultivation of species used for milk treatment (as mentioned in the previous section). For example, some species well-liked for milk treatment such as *Olea europaea* ssp. *africana*, *O. capensis* and *Rhus natalensis* have become extinct on many farms (see Table 2 for the number of households growing these species) and have become rare in the neighbouring natural forest of Mount Elgon. Farmers continue their investigations of the multiplication of indigenous trees which are difficult to propagate due to lack of seeds and/or germination problems, for example *Lippia kituiensis* and *Olea* spp. Some farmers tried to plant cuttings and wildlings (i.e., seedlings collected from natural forests in the area) of *Olea* spp and *Rhus natalensis*, but without much success; however, they continue trying to augment the number of these species on their farms.

L. kituiensis is difficult to propagate because the seeds are very small and therefore difficult to collect. Farmers have also experienced problems getting the seed to germinate; according to them, the species does not germinate and grow on crop land but only in pastures. It was surmised that this could be caused either by the breakage of seed dormancy when seeds pass through the digestive system of animals, or by the seeds being buried too deeply in cultivated fields so that they would not germinate. Research attention to solve this problem would be much appreciated by farmers, as it was presently a much favoured species for milk treatment.

In addition, farmers are engaged in a continuous search for new medicinal plants both for human beings and livestock because the prices of drugs have escalated with a simultaneous decline in the quality of veterinary and health services. Eventually, some of these medicinal species may be tried and used for milk treatment, as many of the species presently used for milk treatment were identified through their prior use as medicinals.

Information sharing.– Although farmers were (and some still are) actively engaged in experimentation on the use and management of trees, they are not sharing findings in any formal, organized methods of communicating information between or within different communities. These findings are similar to findings from research by den Biggelaar (1996) and Sperling *et al.* (1993) in Rwanda. Farmers and communities do learn from each other through informal channels such as observation of each other's practices on the farm and discussions at social gatherings and ceremonies. For example, farmers influence each other in the choice of tree species to plant through these informal ways of sharing information. Mostly, the information shared between communities concerned species with common economic uses such as fuel wood or milk treatment. Information on other, non-economic uses (for example, on medicinals), was rarely shared, as such uses were more tied up in cultural and social believe systems.

CONCLUSIONS

Based on oral history recollections by farmers, the procedures for the treatment of milk have not changed much during the last 300 years, and, besides a change in species used over time, little innovation has taken place to improve them. Milk treatment remains largely a trial and error affair, in which the result cannot be obtained until the milk is ready for drinking, which is expensive in terms of time, money and milk (sometimes milk is lost because of adverse effects or unsuccessful treatment). The technology, therefore, appears to be 'static': There is either no need or opportunity for improving the process, or farmers depend on outside assistance for the further development of the technology (in the form of material, advice or ideas) which is not forthcoming. Innovations in milk treatment that did occur relate largely to the search for alternative species (which was sometimes successful) to treat milk because favored trees became scarce in the environment, or because species encountered in Trans-Nzoia were different from those found in areas where farmers migrated from. The main conclusion from this case study (which was supported by the findings of the other studies in East Africa; e.g. den Biggelaar 1996a; Aluma *et al.* 1996; Njoka and Makenzie 1996) is that knowledge generation is the rule (each time milk is treated is different and a learning experience from which new knowledge is obtained), but innovation is the exception. Networking with other pastoral people both within and outside Kenya (among communities not represented in Trans-Nzoia District such as the Maasai, Somali, Turkana and Samburu; Karamajong and Bayankole in Uganda; and Peul, Touareg, Fulani, Tutsi and Somali and other pastoralists in other parts of Africa) is recommended as one means to improve the technology. It may lead to new ideas, methods and species to be used for milk treatment by encouraging horizontal learning and communication among communities around a theme of common interest.

The goal of FAO's Farmer-initiated Research and Extension Practices initiative was to study and document local (agro)forestry knowledge and technologies with local people and communities in order to facilitate the identification, implementation and evaluation of people's own priorities for tree growing. Following findings of Scherr (1992, 1993) and van der Ploeg (1991), the initiative aimed at generating more reliable research and extension agendas than top-down approaches, assuring that technologies that research does develop are more client-oriented, have greater local relevance, and are better grounded in local dynamics of socioeconomic development. In view of the recommendations of Scherr and van der Ploeg, and in according to Objective 2, this study identified several opportunities for research and extension to collaborate with farmers in three areas which farmers themselves considered key to the continued use and further development of milk treatment: (1) collaboration to solve problems of propagation of favored tree species (i.e., seed dormancy, low and/or difficult germination, availability of seed); (2) sssistance to farmers to raise their own seedling of these species to ensure a long-term, sustainable supply; and (3) investigations into possibilities for expanding the scale of ***mursik*** production and marketing (i.e., studies looking into the demand and supply situation, ***mursik*** quality and storage ability in relation to the different species used to treat the milk, the potential markets for ***mursik*** within and without Trans-Nzoia District, and consumer acceptance of milk not treated by someone from their own ethnic community). The collaboration between farmers and researchers in solving these issues will not only increase the relevance of ongoing scientific agroforestry research and development but more importantly, it will empower, legitimize and enhance the existing endogenous capacities for identifying problems and developing solutions (den Biggelaar 1991).

One issue that is not resolved is the dissemination of innovations and technologies. Farmer-to-farmer extension, even though highly touted in the literature as a promising and cheap(er) alternative to formal extension services, was found to be all but absent in each of the four East Africa studies of the FTPP initiative (Aluma *et al.* 1996; den Biggelaar 1994, 1996a; Mureithi 1996; Njoka and Makenzie 1996). The absence of information and technology sharing was also observed by Sperling and Loevinsohn (1991) in Rwanda, and den Biggelaar (1996b) in Kenya. In addition, formal agroforestry extension activities in the Kwanza and Cherangani Divisions were virtually non-existent, while agricultural and livestock extension activities left a lot to be desired. More investigations and discussions on the role, function and form of both formal and informal dissemination practices is necessary to determine the best ways of informing people of new technologies and innovations, and to share research results.

NOTES

[1] Not all trees identified for use in milk treatment would be considered trees in the Western world view. In Bantu philosophy, however, there is only a distinction between trees (all plants that are not grasses) and grasses (all plants that are not trees) (Kagame, 1958). As the definition of Kagame better reflects farmers' conception of reality, we have adopted it in this study.

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